

Nuclear Smuggling Chains

Suppliers, Intermediaries, and End-Users

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This article analyzes the supply and demand sides in nuclear smuggling, as well as intermediaries between them, based on the 700 illicit trafficking incidents collected by the Stanford Database on Nuclear Smuggling, Theft, and Orphan Radiation Sources (DSTO) for the period 1991 to 2002. The supply side consists of people with access to nuclear and other radioactive material. It can be subdivided into civilian employees at source facilities, ranging from technicians to top managers; military personnel; and security guards. Intermediaries—traffickers and middlemen—can be categorized as amateurs, opportunist businessmen and firms, and organized crime groups. The demand side is represented by proliferating nation states, terrorist organizations, religious sects, separatist movements, and criminal groups or individuals interested in using nuclear and other radioactive material for malevolent purposes, such as murder, deliberate exposure, blackmail, and extortion.

Keywords: nuclear smuggling; illicit trafficking

SUPPLIERS

The supply side consists of individuals who have, or can gain, access to nuclear and other radioactive material.¹ These individuals can be both insiders and outsiders. Insiders include civilian employees at facilities that house nuclear material or radiation sources, military personnel, and security guards. Thefts involving insiders are most common, especially for nuclear material. For example, out of seven known thefts or attempted diversions of weapons-usable² fissile material (Podolsk in 1992, Andreeva Guba in 1993, Sevmorput in 1993, Electrostal in 1994 and 1995, Sukhumi in 1992-1997, and the Chelyabinsk region in 1998), six were committed by insiders. The first and most notorious insider theft occurred at the Luch Scientific Production Association in Podolsk in 1992, when deteriorating economic conditions caused an employee to steal 1.5 kg of uranium enriched to 90% (Cockburn & Cockburn, 1997). The most recent attempted diversion of 18.5 kg of highly enriched uranium (HEU), foiled by the Russian Federal Security Service (FSB), was a result of conspiracy

AMERICAN BEHAVIORAL SCIENTIST, Vol. 46 No. 6, February 2003 822-844

DOI: 10.1177/0002764202239177

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between the employees of one of the Chelyabinsk region's nuclear facilities. Had the Russian intelligence service failed to prevent this diversion, it might have led to the most serious consequences because the amount of material was probably enough to build a nuclear weapon (Bunn 2000). This was also the only credible incident involving weapons-usable material that took place in a closed nuclear city. Other confirmed thefts of weapons-usable material have occurred either at civilian research and production facilities or at military naval sites.

CIVILIAN PERSONNEL

Before the collapse of the Soviet Union, nuclear workers were considered to be the elite of the nation's science and industry and enjoyed the lifestyle of which many Soviet citizens could only dream. However, in 1991, the situation changed dramatically and the once pampered nuclear scientists were faced with a loss of status and low, often delayed, pay. The tight KGB control over the personnel of nuclear facilities was significantly diminished. In addition, the security system of nuclear facilities was designed to guard against threats from outsiders only. An insider with access to nuclear material and the knowledge of how to escape with it undetected was not considered to be a threat, and the measures to protect the material against insiders were very weak and easy to overcome. Thus, the worsened economic conditions and lax security practices created a favorable environment for potential material diversion by the facility personnel.

Insiders at civilian nuclear sites are ideally suited for theft of nuclear material because they know the vulnerabilities of the facility's accounting system and can use them to their advantage. For example, in the past employees managed to escape detection by diverting small amounts of nuclear material every day, just enough to go unnoticed by the accounting system, and thus accumulating a significant amount of the material. This was the case with Leonid Smirnov, a technician from the Luch Scientific Production Association, who over a several-months period in 1992 diverted 1.5 kg of HEU by 25-g to 30-g increments, too small to show on the facility's balance books. During the same year, a similar scheme was used by the employees of the Chepetsk Mechanical Plant in Glazov, Russia, to divert low-enriched uranium (LEU) from the facility. Each month, they were stashing away 4% of the allowed inventory "loss" and within several months were able to accumulate a large amount of LEU and then smuggle it from the plant without alerting the management (Handelman, 1995). After the first seizures of parts of the stolen uranium by the FSB agents, an inventory conducted at the plant revealed that some 300 kg of LEU was missing (Kuznetsov, 2000).

The detailed knowledge of the facility's security system also has helped insider perpetrators steal nuclear material without being detected. In 1995, 1.7 kg of 21% enriched uranium was smuggled out of Electrostal Machine-Building Plant, a major Russian producer of naval and research reactor fuel, by one of its employees in a "shopping bag full of apples." The employee reportedly escaped

detection because the portal monitors were not working at the time and did not set off an alarm ("FSB and Police Shoot" 1997). A year earlier, another worker at the same plant walked out through the gates carrying almost 3 kg of uranium, enriched to 90%, hidden in his protective gloves ("Uranium Transported," 1994).

The financial hardships that most nuclear workers have experienced since the dissolution of the Soviet Union have been the major reason why some of them decided to commit a theft. A metalworker at the Electrostal plant, who diverted 115 kg of uranium dioxide pellets from the facility in 1993, said he did so out of desperation because he had three children to support and his salary, the only family income, had not been paid for months ("Gore and Chernomyrdin," 1997). In some instances, the well-known fact of the pitiful existence of nuclear workers has even influenced court rulings in Russia. Thus, Leonid Smirnov from Podolsk, the first known thief of weapons-grade fissile material, was sentenced to only 3 years probation for the theft of 1.5 kg of HEU. During the investigation, he admitted that he had intended to sell the material to make enough money to buy a new stove and refrigerator.

For Smirnov and many other thieves, the idea of material diversion was prompted by extensive coverage by the mass media. Newspaper reports on nuclear trafficking raised the awareness about the value of such material, often exaggerated, among the general public and thus involuntarily contributed to the increased number of thefts.

MILITARY PERSONNEL

Military facilities, such as naval fuel storage sites and submarine depots, have been frequent targets for thefts of weapons-usable material. Following the collapse of the former Soviet Union, the military sector faced problems similar to those in the civilian sector: poor control and protection of the facilities and aggravated economic conditions of the personnel. As in the civilian sector, insiders were involved in most of the known thefts. Two confirmed thefts of HEU at Andreeva Guba and Sevmorput Shipyard in 1993 were both committed by servicemen from these naval bases. Contract employees of the Northern Fleet were involved in two unconfirmed attempted thefts of nuclear fuel rods from Zvezdochka ship repair plant in 1995 and 1996. According to another unconfirmed report, fuel rods containing at least 7 kg of uranium enriched between 40% and 60% were stolen by three workers from a fuel storage facility in Sovetskaya Gavan of the Pacific Fleet (Lee, 1999). A more recent account reports an arrest of four sailors for stealing parts of submarine equipment containing gold, silver, platinum, and palladium, as well as radioactive fuel, from a nuclear submarine at the Vilyuchinsk-3 submarine base on the Kamchatka Peninsula in the Far East of Russia. The sailors were reportedly advised by a retired radiological safety officer. The suspects said they had intended to sell the precious metals and radioactive fuel ("Russian Servicemen Accused," 2000).

Often, military personnel have also been involved in the theft of radiation sources, such as cesium-137, strontium-90, iridium-192, cobalt-60, and others, from their facilities. In June 1992, three containers with cesium-137 were stolen from a Soviet military base in Poland by the Russian Army deserters ("Russian Army Deserters," 1992). In 1996, a group of former military personnel who specialized in the diversion of cobalt-60 was apprehended in Severomorsk, Russia. The group, led by a former KGB major, reportedly diverted around 10 containers of cobalt-60 (Tarabrin, 1996). In a more recent incident, two cesium radiation sources, which were probably stolen from a former Russian military base in Vaziani, were confiscated from a Georgian defense firm. Two officials of the Georgian Ministry of Defense were among the arrested suspects ("Containers With Radioactive Cesium," 1999).

GUARDS

Security guards at nuclear facilities, both civilian and military, also present a threat to diversion of nuclear material. Susceptible to bribes, they can provide access to storage facilities and switch off the alarm system. Thus, an unknown nuclear dealer describing security practices at Electrostal plant in 1993 claimed that guards could turn off the facility alarm system for a few moments for 1,000 rubles (Lee, 1999, p. 31).

The Stanford database shows that guards have been implicated in at least two nuclear material diversions. In 1992, a whole fuel assembly, containing more than 100 kg of LEU, was stolen from the Ignalina nuclear power plant in Lithuania as a result of collusion between the facility employees and guards. The assembly, 7-m long and weighing 280 kg, was tied to the bottom of the duty bus and carried outside of the premises of the facility unnoticed ("Container With Uranium Discovered," 2002). The 1993 theft at Andreeva Guba naval base of the Northern Fleet also was enabled by the complicity of a guard on duty at the alarm post. The guard allowed two of his accomplices to penetrate the storage facility and remove 1.8 kg of 36% enriched uranium (Cockburn & Cockburn, 1997).

Interestingly, all of the insider thieves of weapons-usable material known to date were low-key personnel ranging from technicians, sailors, and workers to low-rank naval officers. The data on the diversion of non-weapons-usable uranium largely illustrates the same pattern. Nevertheless, even these unsophisticated thieves, sawing through padlocks and clipping alarm wires, were able in all cases but one to divert weapons-usable material without detection and were caught only weeks or months later when their attempts to sell the material attracted the attention of the Russian security services. The lack of involvement of top-level management, scientists, or commandment in the incidents of theft of weapons-usable material may be due to higher moral standards, better understanding of the potential devastating consequences such a theft could lead to, realization that finding a prospective buyer would be a very difficult task, and

better financial situation. However, the lack of data on such incidents also may be a result of more sophisticated diversion schemes. The complexity of possible schemes can be demonstrated by two incidents of diversion of stable and radioactive isotopes, unsuitable for making nuclear weapons, that were orchestrated by facility management personnel.

In April 1993, Russian law-enforcement authorities broke a ring in Sverdlovsk Oblast that traded in stable, nonradioactive isotopes. Although the material was neither radioactive nor weapons-usable, the case was of great concern because the ring consisted of several employees from the closed nuclear city Lesnoy, formerly known as Sverdlovsk-45. The isotopes of ytterbium, rubidium, zinc, and thallium, illegally produced at the Elektropribor chemical combine in Lesnoy, had been shipped abroad for 3 years before the ring was arrested. The head of the Russian State Center for Stable Isotopes, Alexander Podkidyshev, was implicated in the illegal scheme. He made large profits by purchasing the illegal isotopes at below-market prices and then reselling them to his own company in Moscow at a higher price (Dobrynina, 2000).

Another smuggling ring illegally exporting isotopes from a closed nuclear city was uncovered in 1997, when Russian customs officials found a discrepancy between the actual shipment and what was stated in the shipping documents. A group of employees of Radioisotope Factory No. 45 at the Mayak Production Association in Ozersk (formerly Chelyabinsk-65), headed by the factory director, falsified customs declarations and shipped radioactive iridium to a company in the United Kingdom. Within 2 years, several illegal shipments were made until the ring was finally broken (Daughtly, 1998).

The use of legal shipments of radioisotopes for illegal export of nuclear and other radioactive material has been long discussed by the Russian customs officials as a possible way of smuggling. With the currently available radiation detection technology, it is practically impossible for a customs officer to verify if the type and amount of the material inside a shielded container actually correspond to what is stated in the customs declaration (Kravchenko, 2001). An average customs officer will not be able to do isotopic analysis of the shipped material and will have to send it to a special lab. Because this procedure costs money and causes time delay, many customs officers are reluctant to do it, especially if they were mistaken in the past and were reprimanded for adding unjustifiable expenses to the customs post.

OUTSIDERS

Based on the available data, outsiders are very infrequently involved in the theft of nuclear material. One of the few such incidents took place in Sarov, a closed nuclear city formerly known as Arzamas-16 in 1994, when three teenagers stole almost 10 kg of natural uranium and escaped with it through a hole in the fence. According to reports, they wanted to sell the material to obtain enough money to buy video equipment (Williams & Woessner, 1995). Outsider thieves

are, however, a rather frequent phenomenon when it comes to theft of radiation sources. This is likely due to the fact that there are more facilities housing radiation sources than nuclear material and they have less stringent security.

Motive number one for stealing radiation sources is making a profit. Stanford's database contains at least 40 nuclear trafficking incidents in which the stolen radiation sources were intended for resale. Another popular motive behind such thefts is selling the heavy shielding, made of lead or aluminum, for scrap metal. Generally, most thieves do not suspect that the heavy container they have stolen has a highly radioactive element inside and get exposed to harmful, sometimes lethal, radiation doses trying to break the container to extract the valuable metal. In the notorious 1987 Goiania incident in Brazil, thieves stole a powerful radiation source from an abandoned clinic and broke its protective shielding, which they planned to sell for scrap. Within several days of exposure to the glowing powder found inside the container, the thieves, their family members, and many other residents of Goiania were contaminated and four people died due to overexposure. In a similar incident in 2001, local residents stole and disassembled a lead container from a lighthouse belonging to the Northern Fleet Hydrographical Service in the Murmansk region, Russia. The container housed a strong gamma-radiation source. As a result, the thieves were hospitalized with a diagnosis of radiation sickness. ("Today Specialists of the Northern Fleet," 2001). Thefts, in which the rupture of the metal shielding of the sources led to injuries and even fatalities, have occurred in Turkey, Estonia, Chechnya, Azerbaijan, and Thailand (DSTO, 2002).

INTERMEDIARIES (MIDDLEMEN AND TRAFFICKERS)

Intermediaries are individuals, groups, and organizations that find a potential buyer for the stolen material, negotiate a deal (middlemen), and deliver it to the end-user (traffickers). They fall into the categories of amateurs, opportunist businessmen and firms and organized crime groups.

AMATEURS

Amateurs among middlemen and traffickers are the most frequently detected subcategory. Usually, they have little or no knowledge about the nature of the material they are handling. For instance, a butcher from St. Petersburg, who instigated his relative working at Electrostal to steal HEU from the plant, stored the material in his refrigerator so it would not spoil while he was looking for a buyer (Williams & Woessner, 1995, p. 9)! Sometimes, dealing with radioactive material without the necessary caution, amateurs expose themselves and others to harmful doses of radiation. One of the five suspects arrested in Donetsk, Ukraine, in February 2000 in a sting operation had hidden the strontium they were trying to sell in his apartment without shielding it. As a result, residents of

the building, including small children, were exposed to elevated radiation levels (“Crime Unit Confiscates,” 2000).

Many amateur intermediaries mistakenly believe that anything radioactive can be sold on the black market as nuclear technology. In January 2002, Belarusian police arrested a resident of Minsk Oblast who was trying to sell four containers of radioactive strontium-90, which may have been stolen from a military unit, where it would have been used as a standard for checking dosimeters (“Belarusian Police Arrest Suspect,” 2002). In May 2002, another resident of Belarus was arrested in Moscow in a sting operation. Russian authorities confiscated 0.5 kg of depleted uranium from the unemployed man, who was trying to pass it for weapons-grade uranium (“Kilo of Uranium,” 2002). In general, unemployed people are very often involved in nuclear trafficking. At least 14 incidents in Stanford’s database mention the involvement of unemployed individuals.

Sometimes amateur traffickers also get caught while crossing a border into another country. For instance, two Ukrainian nationals, described by officers as “more like ordinary farm workers than experienced smugglers,” were arrested on the border between Ukraine and Moldova in 1998 in an attempt to smuggle a lead container with 11 kg of uranium, which had reportedly been stolen from the Khmelnytsky nuclear power plant in Ukraine. After their arrest, the suspects confessed that they had planned to market the material in Western Europe for a price of \$1.5 to \$2 million (“Ukraine Customs,” 1998).

Amateurs are the least dangerous category of traffickers because they are easiest to detect due to the lack of knowledge about the material they deal with and where to find the potential customers for this material. Some middlemen were even reported to have gone to public markets to look for a buyer. Thus, the butcher from St. Petersburg and his two accomplices—a pipelayer and an unemployed man—had apparently offered samples of HEU at weekly markets in St. Petersburg until they were arrested by law enforcement authorities in March 1994 (Williams & Woessner, 1995, p. 9). Others naively bring their material to government research institutions for analysis to make sure they have the right stuff. In May 2002, six unemployed men were arrested in the Lithuanian capital, Vilnius, after they took almost a kilogram of cesium-133 to the Lithuanian Institute of Physics in Vilnius to verify its value and content (Walsh, 2002).

OPPORTUNIST BUSINESSMEN AND FIRMS

This category of intermediaries encompasses a very wide spectrum of businessmen, small firms, and larger companies. The level of professionalism in this group can vary from amateurish to sophisticated. Some businessmen simply take advantage of an opportunity when offered nuclear material, which they treat “as simply an extension of their legitimate activities” (Williams & Woessner, 1995, p. 9). Others invent complex schemes, establish a steady supply of material, and

set up reliable smuggling channels, such as the one established by Alexander Podkidyshev to smuggle stable isotopes produced at Lesnoy.

Yuri Taimykin, the general director of a small Moscow firm "Tayma" who was approached by his old acquaintance with a request to find a buyer for 1.7 kg of HEU stolen from the Electrostal Machine-Building plant in 1995, belonged to the category of opportunist businessmen. He agreed to sell the uranium for a percentage of the profits but was soon placed under surveillance by the Russian Federal Security Services and then arrested for attempting to sell the material. During the court hearing, he maintained that he did not know he was dealing with uranium ("FSB and Police Shoot," 1997).

Incidents in which firms were involved were more frequently reported in the former Soviet Union in the beginning of the 1990s, when there were ample opportunities for new business activities on one hand and little control and poor law enforcement on the other. Many companies were founded under the cover of research or metal-trading firms but were in fact engaged in the illegal export of rare-earth metals and strategic materials. Driven by a desire for a larger profit, some of them ventured into the smuggling of dual-use, nuclear, and other radioactive material. Thus, in 1996, part of 7 kg of HEU stolen from the Sovietskaya Gavan naval base of the Pacific Fleet was recovered from a metal-trading firm in the Baltic city of Kaliningrad (Lee, 1999, p. 68). In June 1993, the Russian press reported that a group of 10 smugglers trafficking in rare-earth elements and strategic materials had been arrested in Novosibirsk after attempting to take 12 kg of enriched uranium out of the country. The group, led by a businessman from Novosibirsk, was reportedly found in possession of 34 kg of silver, 125 kg of zirconium, and 12 tons of titanium believed to have been stolen in 1992 from one of the defense industry facilities in Novosibirsk. An employee of the Siberian branch of the Russian Academy of Sciences, who may have helped organize the supply of material, was among the gang members ("Zvezdnyi," 1993).

In December 1993, the Black Sea Division of the Ukrainian Ministry of Internal Affairs apprehended a group of smugglers on board a Ukrainian ship bound overseas in possession of 260 pellets of what was apparently LEU (Kuznetsov, 2000). The fuel reportedly originated from one of the facilities in Kazakhstan, most likely the Ulba Metallurgical Plant, which produces nuclear reactor fuel. The smugglers were led by the director of an Odessa-based scientific company and had weapons and false documents on them ("Plot to Smuggle," 1993).

Another Ukrainian research and development firm, based in Kiev, was presumably engaged in the illegal trade in hafnium and zirconium. Ukrainian police operatives seized 3.2 tons of zirconium and 800 kg of hafnium on a plane leased by the company bound for Estonia. More than 6 tons of these materials had allegedly been smuggled to Estonia on two previous flights ("Firm Illegally Exports," 1992). Two other Ukrainian companies, Kontrakt-91 and Buddetal, had reportedly also been involved in zirconium smuggling ("Security Services," 1992). The complexity and magnitude of some transactions, as well as the

resources available to some of the companies, put them on the borderline with organized crime groups.

ORGANIZED CRIME GROUPS

To date, there is no hard evidence to link organized crime groups with nuclear smuggling activities. There have been few confirmed nuclear smuggling cases in which the involvement of organized crime was suspected. However, because of the ease with which organized crime can avoid detection of their illicit activities, the full magnitude of such involvement is difficult to assess. Resourceful and powerful organized crime groups in Russia, Central Asia, the Caucasus, and Eastern and Southern Europe have established smoothly running mechanisms for smuggling drugs and weapons that could be easily adapted to nuclear material trafficking. Although some argue that such groups most likely have no interest in dealing with nuclear material because they are gaining sufficient profits from their other activities and do not want to jeopardize what they have, the consequences of their involvement in nuclear business are too serious not to consider such a possibility.

Networks trafficking in drugs, weapons, and other illicit commodities are well suited for nuclear smuggling. Their experience in avoiding detection, knowledge of safe routes, protection by corrupt authorities, and established infrastructures can be utilized for trafficking in nuclear and other radioactive material. For example, Aleksandr Vanous, a suspected Czech middleman in the 1994 Landshut case in which a sample of 87.7% enriched uranium was seized in a German sting operation, had been previously involved in heroin smuggling and dealt in counterfeit money (Lee, 1999, p. 78).

At least two parallel seizures of nuclear material and drugs have taken place to date. Three men trying to smuggle 1 kg of yellowcake and 350 g of heroin to Pakistan through the Himalayan kingdom of Nepal were arrested by Indian authorities in June 1998. According to Indian police, the suspects "belonged to a gang which has been engaged in smuggling contraband goods to Pakistan" ("Three Indians Held," 1998). In February 2002, during a raid against international drug trafficking, law enforcement officials in Southern Kazakhstan seized 1.5 kg of uranium oxide powder smuggled from Tajikistan via Uzbekistan, together with a large cache of heroin. Kazakhstani officials believed that the arrested Uzbekistani smugglers were part of a ring trafficking in drugs and radioactive materials ("Kazakhstani Officials," 2002).

Another incident indicating the interest of drug trafficking networks in nuclear trade was recorded in Moscow in September 1999. Khikmet Osmalov, believed to belong to a Dagestan-based organized crime group that is allegedly involved in drug trafficking, was detained by the officers of the Moscow Criminal Investigation Department during a routine document check following the September 1999 building explosions in Moscow. He was carrying 2.6 kg of tantalum, nuclear-related, dual-use material, which was reportedly packaged in an

original capsule, suggesting that it was stolen from a factory. At the time of his arrest, Osmalov was also carrying heroin ("Dagestani Condemns," 1999).

Following the September 11 terrorist attacks in Washington and New York, whose impudence and lethality made many believe that terrorist organizations would not hesitate to use weapons of mass destruction, including nuclear, much attention has been given to the members of the Russian organized crime linked with al Qaeda and the Taliban. The two persons who have raised most serious concerns are Victor Bout, a former Soviet military officer accused of large-scale arms-trafficking activities, and Semyon Mogilevich, an Israeli businessman of Ukrainian origin suspected of drug smuggling from Afghanistan and having ties with al Qaeda. In the summer of 2001, European intelligence services produced reports claiming that Bout made \$50 million in profit on weapons sales to the Taliban and possibly bin Laden. Later that year, European sources reported that Mogilevich was approached by al Qaeda representatives with a request to obtain nuclear material. Although both men have denied any involvement with bin Laden and his network, the concern that any of their networks, or any other organized crime groups in Russia, could in principle supply the terrorists with nuclear material if they wanted to do so remains (Ingram, 2002; "Israeli Businessman," 2001). Ties between organized crime and former and active intelligence officials exacerbate the risk of undetected nuclear smuggling (Lee, 1999, pp. 69-71).

If organized crime groups were interested in the acquisition of nuclear or other radioactive material, they would be able to obtain it by bribing the insiders or threatening them or their families. Such a scenario can be envisaged from a 1999 incident, when a criminal group from St. Petersburg approached Yevgeniy Balan, a specialist working at the nuclear-powered icebreaker *Rossiya* in Murmansk, and offered to pay him \$100,000 for the procurement of californium-252, used to start up nuclear reactors ("Tsyganov," 1999). Balan, who was responsible for removing spent nuclear components from the icebreaker, shipped an empty container to the Atomflot storage facility and carried 5 g of californium-252 off the *Rossiya*. Then, together with his accomplice Nikolay Yefimovich, a radiation control technician aboard the service ship *Imandra*, Balan carefully packed the stolen material inside a container filled with paraffin and then placed the container into a canister of water to shield the strong neutron emission. By the time the theft occurred, the criminal group apparently lost the interest in buying the material. The culprits decided to search for a buyer themselves and shortly thereafter were arrested in St. Petersburg. Although no weapons-usable material was involved in this case, it nevertheless validates the concern that if organized crime groups were set to obtain such material, they would be able to find a well-positioned insider and bribe or intimidate him into stealing it for them. In fact, such offers appear to have been made already to those with access to weapons-usable fissile material. According to a military prosecutor of the Northern Fleet of Russia, a Murmansk–St. Petersburg smuggling

ring had approached Russian naval officers offering up to \$1 million for each kilogram of HEU that they obtained (Lee, 1999, p. 68).

So far, there have been more small criminal groups involved in nuclear smuggling rather than large organized crime syndicates. In December 2001, Moscow law enforcement authorities arrested seven men, believed to belong to the Balashikha criminal gang, who were trying to sell 1 kg of LEU stolen from the Electrostal Machine-Building Plant (DSTO, 2002). Another smuggling ring was arrested in Balashikha in March 2001, after several months of surveillance by the Moscow police conducted in Greater Moscow and other Russian cities. The arrest took place when the buyers were going to purchase a sample of a large cache of cesium-137. A total of about 200 g of this material was confiscated from the gang members. The Greater Moscow participants of the deal were acting as middlemen and found the buyers, who, according to the police, were nationals of one of the Middle Eastern countries. During the arrest, the police confiscated a \$250,000 down payment for the sample. The value of the total amount was estimated at \$1.5 million ("Traders in Radioactive Metal," 2001). The confiscated amount of cesium was unusually large as compared to other trafficking cases and could have made a powerful dirty bomb.

Russian criminal groups are not the only organized crime structures that have shown interest in nuclear material. Such interest was expressed by one or more branches of the Italian mafia. Reportedly, Russian organized crime groups received counterfeit merchandise (e.g., clothes, watches) from the Italian mafia and paid for it with highly sophisticated military equipment, heavy and light weapons, and uranium (Williams & Woessner, 1995, p. 12). Indeed, several incidents involving nuclear material of allegedly Russian origin were reported in Italy in the early 1990s. The trafficked material was reportedly to have been delivered to a Middle Eastern country, and former Soviet intelligence officials were implicated in some of the incidents.

More recently, the interest of the Italian mafia in nuclear material was demonstrated again in 1998, when members of several Italian mafia clans, running drug and arms trafficking business, were arrested during an attempted sale of LEU. The confiscated uranium fuel rod, enriched to 19.9%, was stolen from a research reactor in the Democratic Republic of Congo and smuggled to Italy. According to some sources, it was only one of eight rods that went missing from the Congo reactor (Fleishman, 1999). The Italian police believed the remaining rods were hidden somewhere in Italy and after the September 11 attacks they resumed the search for the missing material (Willan, 2001).

END-USERS

Although suppliers and traffickers may divert or acquire material based on a real or perceived market demand, ultimately the concern and threat lies in the end-user of the smuggled material. This section will discuss five categories of

potential end-users for smuggled material and provide some unsettling evidence and anecdotes of activities that may have, or have, resulted in the acquisition of nuclear and other radioactive material by end-users.

PROLIFERATING STATES

When addressing the issues of weapons of mass destruction and nuclear proliferation, the greatest threats are those posed by nation-states with clandestine nuclear weapons programs. Iran, Iraq, and North Korea have all come under close international scrutiny over the past decade as nations seeking weapons of mass destruction. In the Stanford database, they are the most frequently reported destinations for the smuggled nuclear, radioactive, and nuclear-related dual-use material. Iran and Iraq are both mentioned in 10 cases, “a Middle Eastern country” in 7 cases, and North Korea in 6 cases.

These nations are known to have some of the infrastructure needed for the development and deployment of a small nuclear arsenal. The largest impediment is the acquisition of weapons-usable material. For this reason, smuggling nuclear material is of particular concern. The successful transport of 25 kg of HEU or 8 kg of plutonium—IAEA recognized standards for making a nuclear weapon—could make the difference between a security concern and a formidable nuclear threat.

North Korea

Despite North Korea’s growing economic problems, U.S. intelligence agencies are confident that the North Korean military is expanding in both strength and capability. There is no doubt that North Korea has successfully deployed chemical and biological weapons in warheads; the remaining debate is only in their nuclear capabilities (Cordesman, 2002).

In 1993, the United States became aware of plutonium-processing plants in North Korea and soon thereafter an agreement was reached that froze production. Prior to this freeze, however, roughly 13 kg of plutonium had been produced, enough for one or two bombs. In addition, it is estimated that North Korea may have been able to extract enough plutonium for 10 warheads from spent nuclear fuel rods. Combine this with an unsuccessful, but impressive, test of its Taepo Dong-1 multistage missile that demonstrated 2,000-km range and one is left with a technically young, but formidable and dedicated, foe. It is for this reason that the U.S. National Intelligence Council sees North Korea “as presenting the most serious near term threat to the U.S.” (Cordesman, 2002).

Given the considerable nuclear infrastructure already in place in North Korea, as well as its recent admission to having a uranium-based nuclear weapons program, concern naturally arises as to the possibility of smuggled weapons-grade material into the country. A few reports serve to justify this concern. In 1992, unconfirmed reports in the Russian press claimed that Russian officers dis-

mantling nuclear missiles under the START agreement were selling plutonium to North Korea. During this period, it was reportedly quite feasible to obtain nuclear materials from military officers involved with the dismantling process ("Conversion of Military Industry," 1992).

In May 1993, Lithuanian police intercepted a shipment of 4.4 tons of beryllium believed to have been destined for Switzerland and then North Korea ("Russian Mafia Can Steal," 1996). According to IAEA reports, the beryllium was contaminated with 100 g of 50% HEU. The deal was coordinated by trading firms in the Sverdlovsk region with ties to organized crime rings. Using a false purchase order, the firms were able to buy the material from the Institute of Physics and Power Engineering (Oehler, 1996).

When examining the demand side of nuclear smuggling chains, of particular interest are cases that demonstrate active participation by the end-user. For instance, in June 1994, five North Koreans were expelled from Sakhalin Island in Russia for their attempts to obtain what was reported as "nuclear bomb components" ("North Koreans Expelled," 1994). This case was allegedly just one in a series of events in which Russian authorities found North Koreans shopping for missiles and nuclear technologies ("North Korea Shops," 1994).

Iran

As with North Korea, Iran serves as a major point of concern for nuclear smuggling largely due to its established nuclear program and technical infrastructure. Indeed, in October 1991, Deputy President Ayatollah Mohajerani proclaimed that "Iran should work with other Islamic states to create an "Islamic bomb." Reports from the early 1990s indicated that Iran had more than 200 scientists and more than 2,000 technical personnel dedicated to nuclear research (Cordesman, 2002).

Several reports indicate that Iranian intelligence agents have been actively engaged in clandestine procurement of nuclear material and technology. In October 1993, Turkish police intercepted 2.5 kg of natural uranium bound for Iran and arrested a group of smugglers and three Iranian secret service agents, who were likely the buyers of the material ("Uranium Bound for Iran Seized," 1993). In November 1997, in an effort to prevent the illegal export of technology relating to weapons of mass destruction and their delivery systems, the Russian Federal Security Service arrested an Iranian diplomat for attempting to purchase missile designs. He was reportedly contacting members of the Russian defense design bureau and inviting them to travel to Iran on lecture tours. The arrested Iranian diplomat was deported to Iran and, because of his diplomatic immunity, managed to evade prosecution (Verbin, 1997).

In June 2000, Kazakhstani authorities announced the arrest of three suspects and the seizure of 4 kg of LEU fuel pellets used at nuclear power plants. According to the intelligence investigation, the material was destined for Iran via Afghanistan ("An Attempt to Export," 2000). Although many are skeptical about

the danger of LEU smuggling, incidents like this should not be dismissed as insignificant. Whereas HEU and plutonium pose the most obvious threat, nations that have enrichment capabilities can convert LEU into weapons-usable material. With the fast proliferation of centrifuge technologies, this is a real possibility. According to the incidents catalogued in the Stanford database, about 500 kg of LEU has been stolen from research and production facilities, mostly in the former Soviet Union, since 1991. Although most of this material has been recovered as a result of police and intelligence operations, some thefts may have gone unnoticed due to poor accounting practices.

Adding legitimacy to this concern over LEU are recent unconfirmed reports indicating that Iran has initiated a uranium-mining project in Azerbaijan. The mining is taking place in the Nakhichevan Autonomous Republic and apparently the mined uranium ore is transported at night to Iran for enrichment (Aliyev, 2002). If Iran is indeed intending to process the natural uranium and enrich the material utilizing technology they have already developed, then the concern over smuggled LEU is greatly amplified as it is considerably easier to convert LEU to HEU than it is to convert natural uranium to HEU.

Iraq

Along with repeatedly denying UNSCOM inspectors access to suspect factories and facilities until November 2002, Iraq also was found to have “two successful weapons designs, a neutron initiator, explosives and triggering technology needed for production of bombs, plutonium processing technology, centrifuge technology, Calutron enrichment technology, and experiments with chemical separation technology” (Cordesman, 2002).

Although much of Iraq’s infrastructure is believed to have been destroyed during the Gulf War, many uncertainties remain. In particular, is Iraq trying to secure materials and components for nuclear weapons production from sources outside of Iraq? With this in mind, the concern over Iraq as an end-user in nuclear smuggling chains emerges. Several reports justify this concern.

Arzamas-16 (Sarov) director Vladimir Belugin claimed that “Saddam Hussein’s people” had offered the center \$2 billion for a nuclear warhead (“Report of Iraqi Nuclear Warhead,” 1993). In May 1994, German police found a lead container with 6.2 g of highly pure plutonium-239 in the garage of Adolf Jaekle (“Fund 13,” 1994). Although some debate remains about the origin of the material, Jaekle was apparently given a budget of \$100 million to purchase a large quantity of weapons-grade plutonium. Iraq was named as one of the possible destinations for the material (“Germany Issues Nuclear Smuggling Alert,” 1994).

Iraq is also a point of concern when considering the implications of smuggling of LEU. In July 2002, it was reported that Iraqi agents were detected in their attempts to purchase stainless steel tubing components that are critical to the centrifuge process used to enrich uranium. According to U.S. intelligence

officials, obtaining this tubing is essential to Iraq's plans to build nuclear weapons (Gertz, 2002). Again, once the technology is in place and the enrichment process is mastered, it is relatively easy for a military program to convert LEU into weapons-usable HEU.

TERRORIST ORGANIZATIONS

The events of September 11, 2001, clearly focused the world's attention on the scope and capabilities of terrorist organizations. Never before had so few individuals been able to inflict such catastrophic damage. The planning and coordination needed for the attacks of September 11 leave little doubt that if such time and energy were devoted to the acquisition of nuclear materials, the attempts could be successful. With regard to this goal, Osama bin Laden was quoted in a 1998 interview as saying, "If I seek to acquire such weapons, this is a religious duty" (ABC News, 1998).

Indeed, in January 2002, the Associated Press reported that U.S. military officials had uncovered crude diagrams of nuclear weapons in an al Qaeda safehouse in Kabul, Afghanistan. The diagrams described components essential to nuclear weapons, such as uranium and high explosives. Nevertheless, the report documenting this case states that the terrorists are not believed to have a functional nuclear weapon (Lumpkin, 2002).

According to the U.S. Undersecretary of State John Bolton, there is no "doubt that al Qaeda was pursuing nuclear, chemical, and biological warfare capabilities. It's not our judgment at the moment that they were that far along, but I have no doubt that they were seeking to do so" (Boettcher & Arnesen, 2002).

The Department of Energy terrorism expert Gary Richter said that al Qaeda had tried on several occasions to purchase nuclear material. Luckily, however, they appear to have had a tendency to buy the wrong material, and it seems that they lack the technical sophistication to successfully develop nuclear weapons (Lumpkin, 2002).

Although perhaps lacking in technical expertise, one of the weapons documents, labeled "Superbomb," describes a nuclear weapon that would not work but nevertheless demonstrates convincing knowledge of some of the mechanisms for initiating a nuclear explosion (Boettcher & Arnesen, 2002).

Several incidents demonstrate al Qaeda's long-term interest in acquiring nuclear material. Of particular interest is the information provided by Jamal Ahmad al-Fadl, a Sudanese national and al Qaeda defector. According to al-Fadl, he played a key role in laying the foundation for a \$1.5 million purchase of an unknown quantity of uranium from Khartoum, Sudan. At one point during the deal, al-Fadl was shown a cylinder approximately 2 ft to 3 ft tall. Among the many words reportedly engraved on the cylinder, there was a serial number and the words "South Africa," which presumably indicate the origin of the material (McCloud & Osborne, 2001).

During a Nasirbagh refugee camp raid in the Peshawar province of Pakistan in 1998, police confiscated 8 kg to 10 kg of uranium of unspecified enrichment from two Afghani nationals. The suspects, Mujahid Khand and Ghulam Hazrat, were on their way to Afghanistan, where they intended to sell the uranium reportedly bought from Kazakhstan (Frontier Post, 1998). Obviously, given the Taliban and al Qaeda stronghold in Afghanistan, any trafficking of nuclear material in the region becomes of critical concern.

Smuggling of radioactive sources also must be considered when examining the interests of terrorist organizations such as al Qaeda. In June 2002, the group's interest in manufacturing a "dirty-bomb" was widely publicized by the arrest of Jose Padilla, a Chicago criminal with connections to al Qaeda (Ripley, 2002). Padilla had met with Abu Zubaydah, bin Laden's operations chief, in Pakistan and proposed the construction of a nuclear bomb. Zubaydah reportedly recommended that Padilla return to the United States and acquire nuclear waste for use in a conventional bomb that would contaminate an area upon detonation. Luckily, U.S. intelligence intercepted Padilla before he could make any progress with this plan. This case, however, clearly demonstrates al Qaeda's interest in acquiring radioactive sources for terrorist attacks.

Although al Qaeda may be top on the list of U.S. national security concerns, the Tehranian-based group Hezbollah also is suspected to have an interest in, and possibly access to, nuclear material. In March 1999, Lebanese security agents arrested two men, Fu'ad Abduh al-Shuwayri and Butrus Michael Najim, who were allegedly attempting to sell 6 kg of uranium to Syrian nationals with close connections to Iran. The category of uranium was not specified ("Lebanese Trying to Sell," 1999). The original dealer, an engineer known only as Ahmad, told al-Shuwayri that he would like to sell the material to people linked with Hezbollah or Iran for \$210 million. Najim then arranged a transaction with Ali Nayazi Dandesh, an Iranian with close links to Tehran.

Indeed, smuggling aside, some terrorist groups have been quite bold in their attempts to acquire weapons of mass destruction. To this end, noted scholar Rensselaer Lee has cited a fax reportedly sent to a Russian nuclear research center in 1991 (Webster et al., 1996). The letter, apparently from the Islamic Jihad, detailed a request to buy a nuclear weapon from the Russian officials. In June 2000, a similar request was reported, and the Islamic Jihad apparently offered Russian nuclear scientists \$1 billion for an undisclosed amount of HEU and weapons-grade plutonium (Wagner, 2000).

RELIGIOUS SECTS

Initially, the Aum Shinrikyo's nuclear weapons program followed that of a state-run program. By mining natural uranium from their site in Australia, the group appeared to be interested in processing and enriching the fissile materials for their own nuclear weapons (Maerli, 2000). Later, however, that approach was abandoned, perhaps due to prohibitive costs and equipment requirements,

and now the group may be exploring more opportunistic paths toward nuclear weapons.

Although little has been confirmed about the Aum Shinrikyo's intent to acquire nuclear material, the cult has already used weapons of mass destruction in the sarin gas attacks in Tokyo in April 1995. Little doubt remains regarding the cult's connections with well-placed Russian military, political, and scientific figures who could procure nuclear material (Lee, 1999). For example, by bribing a former Russian member of parliament in the Caucasus, the group was able to acquire a Soviet-made M1-17 military helicopter.

SEPARATIST MOVEMENTS

Separatist movements, often considered terrorists by their nation-states, also can be end-users of nuclear and other radioactive material, as was clearly demonstrated by the Chechen militants in 1995. Shamil Basayev, a Chechen field commander, ordered the burial of four radioactive containers in Izmailovsky Park in Moscow and informed a Russian TV station about the location of the sources. Although the radioactivity level of the found containers was not very high, the incident nevertheless caused great concern about the possibility of more serious radiological terrorist attacks in the future. Special radiation search teams were set up in Moscow and some other large Russian cities to detect, secure, and dispose of dangerous radiation sources.

Chechen separatists have repeatedly threatened the use of radioactive material. During the first war in Chechnya in 1995-1996, half of the 900 cubic meters of radioactive waste with radioactivity levels of 1,500 Curies was reportedly found missing from the radon disposal facility situated near Grozny. Despite the speculation that underpaid, demoralized Russian soldiers may have pilfered the radioactive material and sold it to the Chechen militants for a dirty bomb, Russian authorities accused the Chechen militants of recovering radioactive waste from the repository with the purpose of using it in acts of terrorism and sabotage. Thus, two 200-l barrels containing cesium-137 that were buried in the repository in 1983 were found in the region of Gudermes ("There Are No Collections," 1999). Many other radiation sources were found by the Russian Ministry of Emergency Situations in Grozny and other parts of Chechnya in a special search operation conducted during the second military campaign between 1999 and 2002 (DSTO, 2002).

Russian intelligence officials believe that some of the found material was used by Chechen militants to make munitions filled with radioactive material because it was discovered in a workshop for the production of mortars and grenade cup discharges, which had been established before the second campaign and reportedly belonged to Shamil Basayev ("Radioactive Legacy of Basayev," 2001). However, there was only one incident that indicated that dirty bombs were actually deployed by the Chechen militants. In 1998, a container full of radioactive substances was found next to a railway line near Argun with a mine

attached to it. Russian officials considered it a foiled act of sabotage (“Container With Radioactive Substances Found in Chechnya,” 1998).

CRIMINAL GROUPS AND INDIVIDUALS

Another category of end-users encompasses criminal groups and individuals interested in blackmail; extortion; deliberate exposures; and even murders of their business competitors, colleagues, and relatives, as well as politicians and law enforcement authorities. Given the vast supply of poorly guarded radiation sources, incidents of this type were reported in Russia, the United States, Belarus, Moldova, and Japan. Stanford’s database lists a total of 20 malevolent acts using radioactive material.

Two premeditated murders using radiation sources have been reported to date. One occurred in an unspecified country in the West when a scientist who wanted to take his supervisor’s job gave him a watch with a strong radiation source inside. After the supervisor’s death, police were able to find the perpetrator (Leonov, Polenov, & Chebyshov, 2000). A better known incident involves the director of Kartontara packing company in Moscow, Vladimir Kaplun, who died of radiation sickness in 1993 after several weeks exposure to a powerful radiation source installed in the headrest of his chair by unknown people, possibly one of his employees. In Irkutsk, an unknown saboteur used the same technique in an attempt to kill two company directors. Luckily, the “hot seat” was detected and removed before the damage had been done. And in another Siberian town, a man tried to murder his mother-in-law by planting a stolen radioactive element in her basement (Ward, 1994).

In addition to settling personal accounts and eliminating competitors, radiation sources also have been used as means of blackmail. For instance, a box containing radioactive material was stolen in Pridniestrovye in 1992, and the thieves threatened to blow up the material if fighting in Moldova is not stopped (“Radioactive Material Stolen,” 1992).

Politicians also were subject to radiological malevolence. In the United States, a Long Island man was arrested after threatening to kill local politicians by planting radioactive material in their homes. He was reported to have accumulated a “truckload” of old sources and might have been able to inflict real damage (Pillels & Fitzgerald, 1999). In Tokyo, Japanese police arrested a man who had sent letters containing radioactive thorium to the prime minister’s residence and nine other government departments. The letters reportedly included a message warning about ongoing export of nuclear material to North Korea (“Japanese Man Sent Radioactive Letters,” 2000). In March 2002, Belarusian police arrested members of a criminal gang who planned to plant radiation sources in Internal Affairs Ministry offices in two towns in Gomel Oblast. Four containers with radioactive material were seized from the gang members, together with firearms, a grenade, and explosives (“Belarusian Police Seize Weapons,” 2002).

CONCLUSIONS

Most known thefts of weapons-usable and other nuclear and radioactive material have been committed by impoverished insiders in the hope of improving their desperate financial situation. As Rensselaer Lee points out, because they diverted the material on their own initiative rather than in response to someone's order, the nuclear black market we have seen to date is supply-driven (Lee, 1999). However, given the strong interest on behalf of proliferating states and some terrorist organizations in acquiring weapons-usable nuclear and other radioactive material, the demand-driven market may exist as well. However, if this market exists, it remains largely invisible due to the sophisticated smuggling schemes employed by the powerful players, such as organized crime groups and well-placed insiders at source facilities. Unless the accounting and physical protection systems are sufficiently upgraded to guard against insiders at all nuclear facilities in the world that house weapons-usable fissile material, interdiction of nuclear smuggling will remain a challenge and nuclear material falling into the wrong hands will remain a possibility. Poor accounting and security practices for radiation sources worldwide also exacerbate the risk of radiological terrorism and other malevolent acts.

NOTES

1. Although nuclear material is radioactive, the term *nuclear* refers to uranium, plutonium, and thorium or any compound thereof. The term *other radioactive material* refers primarily to ionizing radiation sources such as cesium-137, strontium-90, iridium-192, cobalt-60, radium-226, and so forth.

2. Weapons-usable nuclear material is plutonium-239 and uranium enriched to 20% and over in U-235 (highly enriched uranium [HEU]). Uranium enriched to 90% and over and plutonium containing more than 80% of Pu-239 are referred to as weapons-grade material. Uranium enriched to below 20% is called low-enriched uranium (LEU).

REFERENCES

- ABC News. (1998, December 24). Transcript of interview with Osama bin Laden. Retrieved July 30, 2002, from http://more.abcnews.go.com/sections/world/dailynews/binladen_wnt981224.html
- Aliyev, E. (2002, March 26). Soil containing uranium was carried from Babak and Culfa districts. *Azadlyg*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistraff>
- An attempt to export four kilogram of nuclear material to Afghanistan foiled in Kazakhstan. (2000, July 6). *Interfax*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistraff>
- Belarusian police arrest suspect selling strontium-90. (2002, January 17). *Belarusian Television* (FBIS Document CEP20020117000376). Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistraff>

- Belarusian police seize weapons, radioactive materials from crime ring. (2002, March 6). *Belapan*. (FBIS Document CEP20020306000194). Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Boettcher, M., & Arnesen, I. (2002, January 24). Al Qaeda documents outline serious weapons program. *CNN*. Retrieved January 26, 2002, from <http://www.cnn.com/2002/US/01/24/inv.al.qaeda.documents>
- Bunn, M. (2000, April). *The next wave: Urgently needed new steps to control warheads and fissile material*. A joint publication of Harvard University's Project on Managing the Atom and the Non-Proliferation Project of the Carnegie Endowment for International Peace.
- Cockburn, A., & Cockburn, L. (1997). *One point safe*. Garden City, NY: Doubleday.
- Container with radioactive substances found in Chechnya. (1998, December 29). *ITAR-TASS*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Container with uranium discovered in Lithuania. (2002, March 16). *Russian Information Agency Novosti*. Retrieved March 20, 2002, from <http://www.nuclear.ru>
- Containers with radioactive cesium discovered in Georgia. (1999, February 26). *Interfax*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Conversion of military industry brings in good profit to smugglers. (1992, April 6). *Russian Press Digest*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Cordesman, A. H. (2002, January 30). *Proliferation in the "Axis of Evil": North Korea, Iran, and Iraq*. Center for Strategic and International Studies, Washington, DC. Retrieved February 28, 2002, from http://www.csis.org/burke/proliferation_axis.pdf
- Crime unit confiscates 28 strontium-90 containers. (2000, February 25). *Ukrainian Television UT3 (Kiev)*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Dagestani condemns police to the torments of Tantalum. (1999, September 11). *Segodnya*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Daughtly, E. E. (1998). NIS nuclear smuggling since 1995: A lull in significant cases? *Nonproliferation Review*, 5, 122.
- Dobrynina, S. (2000, June 30). Engineer Tunin's hyperboloid. *Novyye Izvestiya*, pp. 1, 7. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- DSTO. (2002). Database on nuclear smuggling, theft and orphan radiation sources. Center for International Security and Cooperation, Institute of International Studies, Stanford University (restricted access).
- Firm illegally exports rare-earth metals. (1992, November 27). *FBIS-Central Eurasia*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Fleishman, J. (1999, January 12). Sting unravels stunning mafia plot. *Philadelphia Inquirer*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Frontier Post. (Peshawar). (1998, September 24). Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- FSB and police shoot at each other because of uranium peddlers. (1997, November 14). *Kommersant Daily*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Fund 13: Alarmstufe Rot. (1994). *Der Spiegel*, No. 29. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Germany issues nuclear smuggling alert. (1994, August 20). *New Scientist*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Gertz, B. (2002, July 26). Iraq seeks steel for nukes. *Washington Times*. Retrieved July 26, 2002, from <http://www.washtimes.com/national/20020726-23093280.htm>
- Gore and Chernomyrdin helped stop uranium theft. (1997, November 14). *Kommersant Daily*, p. 7. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Handelman, S. (1995) *Comrade criminal: Russia's new mafia*. New Haven, CT: Yale University Press.

- Ingram, J. (2002, March 5). Alleged Russian arms trafficker denies accusations that he aided al-Qaida. *Associated Press*. Retrieved July 4, 2002, from Lexis-Nexis Universe database at <http://www.lexis-nexis.com/universe>
- Israeli businessman Semyon Mogilevich denies allegations that he intended to sell nuclear material to Osama bin Laden. (2001, September 28). *RIA Novosti*. Retrieved July 4, 2002, from Integrum Worldwide Service database at <http://www.integrum.com>
- Japanese man sent radioactive letters (2000, June 17). *BBC World Service* Retrieved June 17, 2000, from BBC Web site.
- Kazakhstani officials confiscate 1.5 kg uranium oxide, heroin. (2002, March 11). *Interfax*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistraff>
- Kilo of uranium can be bought even in a street. (2002, May 23). *Vechernyaya Moskva*. Retrieved from Integrum World Wide Service database at <http://www.integrum.com>
- Kravchenko, N. (2001, May 7-11). *Prevention of the use of legal trafficking for nuclear material and radioactive sources smuggling*. Proceedings of the IAEA International Conference "Security of nuclear material: Measures to prevent, intercept and respond to illicit uses of nuclear material and radioactive sources," Stockholm.
- Kuznetsov, V. (2000, March/April). On physical protection of nuclear power installations of Russia. *Yadernaya Bezopasnost*, No. 34-35.
- Lebanese trying to sell uranium to Iran reportedly caught. (1999, March 18). *Al-Nahar* (Beirut). Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistraff>
- Lee, R. W. (1999). *Smuggling armageddon: The nuclear black market in the former Soviet Union and Europe*. New York: St. Martin's Griffin.
- Leonov, A. F., Polenov, B. V., & Chebyshov, S. B. (2000). Modern methods and technical means to counter radiation terrorism. *Ecologicheskiye Systemy I Pribory*, 5, 7-10. Retrieved July 2, 2002, from Polimaster Web site at <http://www.polimaster.com/ru/support/docs/polienov.htm>
- Lumpkin, J. J. (2002, January 31). Al-Qaida had crude nuclear diagrams. *Associated Press*.
- Maerli, M. B. (2000, Summer). Relearning the ABC's: Terrorists and "weapons of mass destruction." *Nonproliferation Review*. Retrieved from <http://cns.miis.edu/pubs/npr/vol07/72/72maerli.pdf>
- McCloud, K., & Osborne, M. (2001). *WMD terrorism and Osama Bin Laden*. Retrieved April 22, 2002, from <http://cns.miis.edu/pubs/reports/binladen.htm>
- North Korea shops for nuke technology in Russia. (1994, July 5). *Washington Times*, p. 1. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistraff>
- North Koreans expelled for nuclear parts purchase attempt. (1994, June 16). *FBIS-SOV*, p. 8. (Original source: Seoul KBS-1 Radio Network, June 15, 1994.) Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistraff>
- Oehler, G. C. (1996, March 27). *The continuing threat from weapons of mass destruction, Appendix A: Chronology of nuclear smuggling incidents*. Statement for the Record to the Senate Armed Services Committee.
- Pillels, J., & Fitzgerald, T. J. (1999, November 21). Nuclear tools of terror could destroy in silence. *Record* (Bergen County, NJ), p. a17. Retrieved October 20, 2001, from Lexis-Nexis Universe database at <http://www.lexis-nexis.com/universe>
- Plot to smuggle radioactive material from CIS foiled. (1993, December 24). *Guardian*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistraff>
- Radioactive legacy of Basaev. (2001, April 2). *Vremya Novostei*. Retrieved October 15, 2001, from <http://www.vremya.ru/2001/57/2/11266.html>
- Radioactive material stolen from Transdniestr. (1992, April 3). *JPRS-Proliferation Issues*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistraff>
- Report of Iraqi nuclear warhead purchase at Arzamas-16. (1993, July 13). *UPI*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistraff>
- Ripley, A. (2002, June 16). The case of the dirty bomber. *Time Magazine*. Retrieved July 30, 2002, from <http://www.time.com/time/nation/article/0,8599,262917,00.html>

- Russian army deserters reportedly stole Cs-137. (1992, July 10). *JPRS-Proliferation Issues*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Russian Mafia can steal nuclear materials. (1996, October 14). *Reuters*. Retrieved from Stanford Database on Nuclear Smuggling, Theft and Orphan Radiation Sources (DSTO).
- Russian servicemen accused of theft. (2000, February 1). *New York Times*. Retrieved February 2, 2000, from <http://www.nytimes.com>
- Security services investigate smuggling of strategic materials. (1992, October 28). *FBIS-Central Eurasia*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Tarabrin, A. (1996, February 9-16). Hunters of deadly trade. *Pravda*, p. 3. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- There are no collections of substances on the territory of Chechnya, whose leakage may lead to ecological disaster, says Head of the Ministry of Defense's Radiation Safety Department. (1999, December 15). *RBK*. Retrieved October 15, 2001, from <http://www.cry.ru>
- Three Indians held for trying to smuggle uranium to Pakistan. (1998, June 16). *Agence France Presse*. Retrieved November 2001 from Lexis-Nexis Universe database at <http://www.lexis-nexis.com/universe>
- Today specialists of the Northern Fleet liquidated a powerful radiation source in the Murmansk Region. (2001, June 10). *Russian Television ORT*. Retrieved October 2001 from <http://www.rambler.ru/db/news/msg.html?mid=1715047>
- Traders in radioactive metal were arrested in Podmoskovie. (2001, March 10). *Russian Television ORT* (FBIS Document CEP20010110). Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Tsyganov, A. (1999, July 15). Sailors traded in isotopes from icebreaker. *Kommersant*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Ukraine customs detain two for nuke smuggling. (1998, December 4). *Reuters*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Uranium bound for Iran seized. (1993, October 7). *Guardian*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Uranium transported in a passenger railcar and stored in a cool place. (1994, June 16). *Novaya Yezhednevnyaya Gazeta*, p. 1. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Verbin, A. (1997, November 14). Russia detains Iranian trying to buy missile plans. *Reuters*. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>
- Wagner, B. (2000, June 2). Buying Russia's excess nukes should be Clinton's top priority. *San Francisco Chronicle*. Retrieved July 30, 2002, from <http://www.sfgate.com/cgi-bin/article.cgi?file=/chronicle/archive/2000/06/02/ED93876.DTL>
- Walsh, N. P. (2002, June 1). Six arrested, one sought in radioactive "dirty bomb" plot. *Guardian*. Retrieved June 1, 2002, from <http://www.guardian.co.uk/Archive/Article/0,4273,4425786,00.html>
- Ward, O. (1994, January 25). Deadly dose of radiation is murder . . . Russian-style, fears on rise about nuclear terrorism. *Toronto Star*, p. A18. Retrieved November 2001 from Lexis-Nexis Universe database at <http://www.lexis-nexis.com/universe>
- Webster, W. H., de Borchgrave, A., Kupperman, R., Peterson, E., Cilluffo, F., Mullen, S., et al. (1996). *The nuclear black market*. Washington, DC: Center for Strategic and International Studies.
- Willan, P. (2001, November 9). Race to find mafia's uranium bars: Police fear terrorists may get ingredients for "dirty bomb." *Guardian*, p. 7. Retrieved from Lexis-Nexis Universe database at <http://www.lexis-nexis.com/universe>
- Williams, P., & Woessner, P. N. (1995). Nuclear material trafficking: An interim assessment. *Ridgeway Viewpoints*, 95(3), 9.
- Zvezdnyi. (1993, June 7). *Kommersant*, p. 28. Retrieved from NIS Nuclear Trafficking Database at <http://www.nti.org/db/nistr Traff>

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